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(54) Title: METHOD FOR THE REPAIR OF THE INSIDE OF INSTALLED CONDUITS

(57) Abstract

The novel method for the repair of the inside of installed conduits comprises the following method steps: drying of the inside of the line by flow-through of pre-dried compressed air, removal of interior coatings by flow-through of a mixture of compressed air and particles of an abrasive medium with a mean exterior diameter of > 0.8 mm and a specific weight of > 3.0 $g.cm^{-3}$ in an amount of > 1.0 $g.Nm^{-3}$, the mixture flowing through the line with a mean speed of > 10 $m.s^{-1}$, relative to normal pressure, and blowing out the line by means of pre-dried compressed air. The adhesive resin utilized for the subsequent coating contains, among others, a solvent-free 2-component resin and at least 5 % by weight of finely dispersed inorganic oxidic adhesives.

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METHOD FOR THE REPAIR OF THE INSIDE OF INSTALLED CONDUITS

The invention described herein relates to method for the repair of the inside of installed conduits. Such conduits are, for example, supply and drain pipes for water or gas in residential, industrial and public installations up to an O_i of approximately 200 mm; included in this are residential and industrial waste water lines.

The problem of incrustation of these conduits has been long known. Such incrustations are mainly based on calcium deposits from water, formation of rust in the conduit, other precipitates from the water, reaction products between substances contained in the water and the metal of the conduit, etc. Combinations of the known effects are also known.

Such incrustations are particularly annoying in connection with conduits which are inside walls or laid in the ground; this type of laying of conduits is the one more customary today. In connection with conduits which are laid in the open it is possible, if required, after removal of a part of the conduit, to clean the sections ahead and behind the opening mechanically by means of brushes which are pulled through or similar devices.

British GB A 2 140 337 teaches and claims a method according to the same species. Characteristic herein is that the cleaning flow as well as the resin mix flow pulsingly flow through the conduit to be repaired. Furthermore, size and amount of the abrasive particles added to the cleaning flow are not defined and the addition of adhesive materials to the repair resin also with particle sizes defined is not mentioned.

In accordance with the present invention it is just this combination of special additives which results in a satisfactory cleaning and even, well-adhering coating with resin of the inner wall of conduits, even without pulsing of the carrier flow.

In contrast to the method discussed just now, the method for cleaning and re-coating of the inner walls of utility water according to the invention basically differs in that it is optimized as a total method and thus leads to assured results.

Already, installed utility conduits are cleaned today by means of compressed air with or without the addition of sand, and such pre-cleaned conduits are already being dusted with reactive resins by means of compressed air. However, the inventors of the method described here have had the experience that most of the cleaning of this type primarily is based on individual knowledge of a routine type. Only the combination of the process steps in accordance with the method of the invention defined in the claims with the use of the adhesive resin also characterized in the claims results in a method for cleaning and interior coating of utility conduits which has a sufficiently assured effect. The final goal of this development is intended to be the set-up of computer-controlled installations.

In connection with a relatively known cleaning method on a primarily routine basis, compressed air is applied to the conduit to be cleaned by compressor installations which are mobile, if required. During a first phase, pre-drying is performed only by means of air warmed by compression. Subsequently, in a second phase, sand is added to the air flow. It is important that the air-sand mixture is conducted through the conduit with a spiral movement; movement of the mixture in a normal way is particular considered to be ineffective.

During a third phase of the known method a reactive resin is sprayed into the conduit and distributed therein, again by means of a spirally moving compressed air flow.

Furthermore, the method of the invention also differs in regard to the techniques of the method steps:

- heating of the conduit system for drying is not required because the water absorption power of the pre-dried air greatly increases during expansion.

- a spiral movement of the air-sand mixture appears not necessary when working under overpressure; additionally, only during this step of the method of the invention heating of the conduit system is achieved which is, compared with the methods of the state of the art, advantageous in respect to energy.

- coating of the inside takes place by adding the processed resin to the conduit in the form of plugs; atomization of the resin before setting is to be avoided as much as possible.

A considerable chemical difference of the adhesive resin for the inner coating in accordance with the invention in respect to the known coating media is to be noted: the resin used according to the invention contains at least 5% by weight of oxidic adhesives, preferably SiO_2 aerosols and shows a viscosity of $> 2 \cdot 10^4$ m Pa·s (25°C) prior to being fed into the conduit which was heated in the meantime. According to observations made by the inventors, conduits can be coated with this adhesive resin in the direction of flow of the water as well as against it with satisfactory results.

The method of the invention for the accelerated cleaning and re-coating of the inner wall of a water line is characterized by the following method steps:

- Drying of the inside of the line by flow-through of pre-dried compressed air,

- Removal of interior coatings by flow-through of a mixture of compressed air and particles of an abrasive medium with a mean exterior diameter of > 0.8 mm and a specific weight of $> 3.0 \text{ g} \cdot \text{cm}^{-3}$ in an amount of $>1.0 \text{ g} \cdot \text{Nm}^{-3}$, the mixture flowing through the line with a mean speed of $> 10 \text{ m} \cdot \text{s}^{-1}$, relative to normal pressure, and

- Blowing out the line by means of pre-dried compressed air.

In the said method, dry silicate sand having grain size limits between 0.8 to 8 mm, preferably of 2 to 4 mm, is advantageously used as abrasive medium in a proportion from 1 to 100 g/Nm^3 of air. In the same method the theoretical velocity of the air-sand mixture in the conduit is approximately 50 m/s, relative to normal pressure.

During cleaning the overpressure in the system is at least > 1 bar, preferably > 2bar, relative to normal pressure.

It is furthermore advantageous that the addition of the adhesive resin, after it has been prepared, takes place in the form of plugs.

The adhesive resin to be used in accordance with the invention contains a solvent-free 2-component resin and at least 5% by weight of finely dispersed inorganic oxidic adhesives having a mean outer diameter of < 0.08 mm, the viscosity of the adhesive resin at 25° being at least $2 \cdot 10^4$ m Pa•s.

The said 2-component resin is preferably an epoxy resin with a hardener and contains as oxidic adhesives particles primarily of SiO_2 with a lower grain size limit of approximately 10 μm.

As an example of the method according to the invention, use of the same for cleaning the supply water line for a private swimming pool is being reported.

After closing off all branch lines the inlet and outlet of this conduit were opened a day earlier.

On the day of operation itself the conduit was first pre-dried with compressed air from a construction compressor. The compressed air was pre-dried in a moisture separator before entering the conduit.

The required amount of air was calculated (as was

subsequently done in connection with the cleaning and coating) from the table below:

NW 15 mm - 1/2"	Conduit length up to 100 m	7.5 m^3/min.
NW 20 mm - 3/4"	ditto	7.5 m^3/min.
NW 25 mm - 1"	ditto	7.5 m^3/min.
NW 32 mm - 5/4"	ditto	10.0 m^3/min.
NW 40 mm - 1 1/2"	ditto	14.0 m^3/min.
NW 50 mm - 2"	ditto	17.0 m^3/min.
NW 65 mm - 2 1/2"	ditto	24.0 m^3/min.
NW 80 mm - 3"	ditto	26.0 m^3/min.
NW 100 mm - 4"	ditto	30.0 m^3/min.
NW 125 mm - 5"	ditto	35.0 m^3/min.
NW 150 mm - 6"	ditto	45.0 m^3/min.

However, the amounts of air indicated can vary greatly depending on the amount of branch lines and the degree of incrustation of the conduit.

In the present case the total length of the conduit was approximately 70 m; it mainly consisted of 1" and 1 1/2" pipes. The conduit was partially embedded and partially laid underground outdoors.

Pre-drying took approximately 30 minutes. A special separator was installed at the conduit outlet; the fine solid material exiting (apparently mainly calcium deposits and rust) entered a special separator.

Then a feeding device for the abrasive medium (dry regular sand with a grain size of 2 to 4 mm) was installed in the conduit between the compressor and the air inlet. A separator with a cyclone separator with pressure gauge and regulating valve was installed at the air outlet. Then work was done for approximately 8 minutes at a mean overpressure of approximately 1 atmosphere at highest compressor output

and greatest abrasive medium feed. At the end of blowing approximately 200 kg of abrasive medium had been blown through the conduit to be cleaned. At the end of blowing the air exiting at the separator had a temperature of ~50°C.

After a short period of blowing out, batches consisting of 4 kg adhesive resin each of the following composition were prepared; the resin was prepared so that it showed a viscosity of more than $2 \cdot 10^4$ Pa·s at approximately 25°C. The batches then were poured in the form of plugs into the air inlet (vertical) at the beginning of the conduit. The compressed air was immediately connected and the plug was then blown until clear resistance was no longer noted. Then another resin plug was inserted, etc. for a total of four times. Only at that time was discharge of resin from the end of the conduit noted.

Basic Composition of the LSE Coating

Epoxy resin:	Bis-A or bis-A/F type	47% by weight
Hardener:	Aliphatic polyamine adduct	19% by weight
Titanium dioxide		4% by weight
Ferric oxide red		10% by weight
Silicate filler		15% by weight
Thixotropy (silicate)		5% by weight
TOTAL		100% by weight

Finally, blowing was done for 30 minutes and the conduit was closed on top and bottom at the end of the blowing time.

Two days later the conduit was reconnected to the net and was thoroughly flushed initially.

Filling the pool after cleaning the conduit took approximately eight hours and resulted in clear water; prior

to cleaning filling took more than 14 hours and the water was colored rust-red at times.

PATENT CLAIMS

1. A method for the repair of the inside of installed conduits, characterized by the following method steps:

- drying of the inside of the line by flow-through of pre-dried compressed air,
- removal of interior coatings by flow-through of a mixture of compressed air and particles of an abrasive medium with a mean exterior diameter of > 0.8 mm and a specific weight of > 3.0 g · cm^{-3} in an amount of >1.0 g · Nm^{-3}, the mixture flowing through the line with a mean speed of > 10 m · s^{-1}, relative to normal pressure, and
- blowing out the line by means of pre-dried compressed air.

2. A method in accordance with patent claim 1, further characterized in that

- blowing out of the line by means of pre-dried and pre-heated air is conducted until the outside temperature of the line is >40°C,

and in that

- subsequently the interior coating of the line is performed by means of blowing in and blowing around of adhesive resin by means of compressed air, the adhesive resin being a solvent-free, self-setting resin with at least 5% by weight of inorganic oxidic adhesives with a mean diameter of < 0.08 mm.

3. A method in accordance with patent claim 1, in which the abrasive medium particles have a mean diameter of 0.8 to 8.0 mm, preferably one of 2 to 4 mm.

4. A method in accordance with patent claim 1, in which the mean air velocity is > 50m/s, relative to normal pressure.

5. A method in accordance with patent claim 1, in which the overpressure in the conduit is > 1 bar, preferably > 2 bar, relative to normal pressure.

6. A method in accordance with patent claim 1, in which the addition of the adhesive resin after its preparation takes place in the form of plugs.

7. A method in accordance with patent claims 1 and 2, characterized in that the pressure difference required for the flow through the line is created at least partially by drawing off the air at the end of the line, i.e. by means of a vacuum.

8. An adhesive resin for use in the method according to patent claim 1, containing

- a solvent-free 2-component resin, in particular an expoxy resin with hardener, and
- at least 5% by weight of finely dispersed inorganic oxidic adhesives having a mean outer diameter of < 0.08 mm, the viscosity of the adhesive resin at 25° being more than $\cdot 2 \cdot 10^4$ m Pa•s.

9. Installation for performing the method in accordance with patent claims 1 to 7, including, besides the compressor for the compressed air,

- a distributor for the compressed air, from which compressed air can be injected into the conduit system to be cleaned at a plurality of outlets by means of respective regulating valves;

- a feeder, by means of which the flow of compressed air to a branch of the conduit system can be charged with a granular abrasive medium, and
- a separator in which the air coming out of the conduit system is cleaned and the separated solid particles can be separated by means of a cyclone into abrasive medium particles and rust and/or separation particles.

INTERNATIONAL SEARCH REPORT

International Application No PCT/EP 88/00586

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: B 24 C 3/32; B 05 D 7/22; F 16 L 58/10

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System [8]	Classification Symbols
IPC[4]	B 05 D; B 08 B; B 24 C; F 16 L; F 28 F; F 28 G

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [9]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	GB, A, 2140337 (NIHON PLANT SERVICE CENTRE) 28 November 1984 see the whole document (cited in the application)	1-6,8,9
A	DE, A, 3235506 (MARUBENI) 29 March 1984 see pages 9-11; figures 1,4,5	1-9
A	US, A, 3139704 (McCUNE) 7 July 1964 see columns 2,6-9	1-5
A	FR, A, 2526124 (HAKKO) 4 November 1983 see pages 5-9; figures 1,9,10	1,2,7-9
A	Patent Abstracts of Japan, volume 6, no. 191 (C-127)(1069), 30 September 1982, & JP, A, 57105270 (KINZOU FUJII) 30 June 1982 see figures	1,2,6
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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
28th September 1988	25. 10. 88
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	P.C.G. VAN DER PUTTEN

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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
	see figures 1-6	
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A	US, A, 4327132 (SHINNO) 27 April 1982 see columns 3,5; figure	2,8
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A	DE, A, 1471510 (UNITED STATES STEEL CORP.) 19 December 1968 see pages 9-13	2,8
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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. EP 8800586 SA 22987

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 12/10/88
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82